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Transceiver for data signals, system for transferring data signals, apparatus for installation in a transceiver, and synchronization method

BACKGROUND OF THE INVENTION

A 1. Field of the Invention

This invention relates to a transceiver for data signals, in particular radio data signals.

A 2. Description of the Prior Art

The term "data signals" includes any kind of signal containing data (messages), for example audio, video or computer data, but also control data and the like.

The term "transceiver" refers to a device suitable for both transmitting and receiving data signals. An example of a transceiver is a CB radio set. However, the invention is fundamentally applicable to all devices suitable for receiving and transmitting data. The advantages of the invention are particularly clear in radio data transfer, but the invention is also suitable for transfer over wire-bound channels.

The term "communication link" thus involves for example a group of radio channels/frequencies, but also a group of channels in a network-bound communication system. The term "channel" in intended here to refer specifically to a certain frequency band from a plurality of frequency bands. However, it is also fundamentally possible within the scope of the invention to realize individual channels of a communication link by corresponding time windows in a predetermined time slot.

The invention is executed in particular as a discrete apparatus which can be installed in existing conventional transceivers to process transmit signals and/or receive signals. The invention thus provides a data transfer device with which one can equip devices used for data transfer e.g. to protect transfer from "eavesdropping".

The invention can be explained here specifically by the example of CB radio. A disadvantage in current radio transmissions is the ready possibility of eavesdropping and logging data, for which purpose one need simply connect a transceiver into the channel over which two transceivers are communicating with each other.

Encryption of transmitted data by cryptographic measures is relatively elaborate, the data can be logged, i.e. recorded and decrypted later.

A further disadvantage in radio transmissions is the possibility of a stronger transmitter interrupting a connection between two users by the stronger signal simply displacing the weaker signal.

The change of available channels of a communication link during a communication process is known in a special embodiment as frequency hopping. For example, DE 27 47 454 C1 shows a communication system with frequency hopping. The message (data) to be transmitted are modulated in sections upon different carrier frequencies, the cyclically changing sequence of the carrier frequencies being programmed according to a given protocol. Frequency hopping offers the advantage, among other things, of obtaining relatively high safety from eavesdropping. So that the receiver can completely receive the message sent by the transmitter, the receiver must retrace the frequency hops in synchronism with the transmitting operation.

Synchronizing transmitter and receiver requires considerable effort. One possibility is the so-called hand-shake method by which transmitter and receiver first exchange synchronization signals as preparation for transmitting a message and then start actual message transmission when synchronization has been effected. Both the initiation of message transmission and the message transmission itself follow a strictly prescribed protocol. It is known to reserve a separate channel for purposes of synchronization (US-A-5 502 722).

It is furthermore known in transmission of short messages by frequency hopping to transmit the message several times asynchronously to the receiver which is synchronized with the transmitter until a message has been completely received once (DE-A-43 37 212). Because of the special synchronization between transmitter and receiver it is virtually impossible in the prior art for a third user to cut into an ongoing call. Such cutting in or operator override by one or more further users may be advantageous specifically in speech transmission systems (for example CB radio) when it is expressly desired by the two original callers. Operator override would require considerable synchronization effort in the prior art, comparable with the effort required for setting up a connection between a transmitter and a receiver.

3. Summary of the Invention

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The invention is based on the problem of providing an apparatus which permits safe data transfer with simple means along with fast and simple synchronization of transmitter and receiver. Furthermore, a simple and reliable synchronization method is ~~to be stated.~~

This problem is solved according to the invention in a transceiver for data signals that has the following features:

a transmitting section which conditions input data for transmission over a communication link containing a plurality of channels,

a receiving section which receives signals from one of the channels and processes them into output data,

a channel switching device connected to the transmitting section and receiving section,

a channel hopping program part in which a plurality of predetermined channel hopping sequences are programmed, a predetermined channel hopping sequence being associated with the transceiver as an address,

a channel selecting device which controls the channel switching device in accordance with a predetermined channel hopping sequence, and

a clock device for operating the channel selecting device, the clock device being synchronized by a public time signal (radio clock) to synchronize channel hopping between a transmitting and a receiving transceiver with the aid of the public time signal.

The transmitting section conditions the data, for example audio data, from a data signal source for radiation through an antenna. The thus conditioned data signals have a certain transmitter frequency, and thus accordingly a certain channel.

The same applies to the receiving section. The channel switching device provides a constantly changing selection of one channel from the amount of available channels. The clock device provides the clock whose frequency determines how fast hopping between the different channels takes place. The special channel hopping sequence is unique and identical for each connection between two or more users. Furthermore, the clock device provides the sync signals derived from the public time signal.

In a communication system each transceiver is equipped for example with a special identification number, said identification number being uniquely linked with a special channel hopping sequence, i.e. in particular frequency hopping sequence.

Each transceiver, i.e. in particular the inventive data transfer device installed in the transceiver, contains the information on this link for all transceivers, e.g. stored in an EPROM. A device in the standby state cyclically performs its particular channel hopping sequence.

When the transmitting device calls a desired user by entry of the receiver's identification number, the channel hopping sequence belonging to the selected identification number is adjusted in the transmitting device. The clock device synchronizes the channel hopping sequence in the transmitting device. Change-over is typically effected in the order of magnitude of one megahertz, corresponding to a dwell time of approximately one microsecond within a channel. Synchronization is effected with the aid of the public time signal, thus being obtained quickly and easily.

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The receiver called by a transmitting device confirms dialing, and the transmitting device synchronizes itself with the receiver. Since only said two devices work in synchronism in the channel hopping sequence specific to this connection and stay only in the particular channel for only a relatively short time, one obtains protection for the transferred data signals, on the one hand, and prevents a stronger signal from being ~~able to terminate the connection, on the other hand.~~

Utilization of the public time signal (DCF 77 in Germany; MFS in the United Kingdom; WWVB in the USA) permits the two communicating devices to be perfectly synchronized, for which one can use the basic minute and second clock signals of the public time signal which is identical and synchronous world-wide. Any desired sync signals can be derived from said time signal.

The inventive system for transferring data signals contains a number of transceivers each formed according to the invention and having a unique identification number. Said identification number determines the channel hopping sequence with which this device communicates with another device, namely as a receiving device, that is, a device dialed by another device. For connection setup the identification number sent by a transmitting device also determines the predetermined channel hopping sequence in the transmitting device itself. This excludes other users from taking part in data transmission. Another user's attempt to cut into the ongoing call is excluded with very high probability since the two users' time synchronization is unknown to outsiders.

Excluding further users from data transmission is an advantage of the present invention, but the invention also offers the converse possibility of two users involved in data transmission expressly permitting one or more further users to take part. For this

purpose the synchronization of ongoing data transmission is halted temporarily and started again after a pause so that a further user can take part after the start.

The special kind of in particular cyclical channel hopping sequence may be stored in the program part. However, one may also determine the channel hopping sequence from the identification number by calculation with the aid of an algorithm.

The invention furthermore provides an apparatus suitable for retrofitting which, to adapt to the particular transfer device, ensures a certain continuous channel hopping during a data transfer, synchronized with one or more receivers. In particular, the invention provides a data transfer device for installation in a communication device which sends data to another device and/or receives data from the other device over one of a given number of channels, in particular frequency channels, comprising the following features:

a channel switching device,

a channel hopping sequence program part in which a plurality of predetermined channel hopping sequences are programmed, a predetermined channel hopping sequence being associated with the data transfer device,

a channel selecting device which controls the channel switching device in accordance with one of the predetermined channel hopping sequences, and

a clock device with a synchronizing device for operating the channel selecting device,

the clock device being synchronized by a public time signal (radio clock).

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The invention furthermore provides a method for synchronizing transceiving operation between a transmitter and a receiver which are connected over a communication link with cyclically hopping channels, comprising the following steps:

the transmitter (A) dials a desired receiver (B),

the same channel hopping sequence is adjusted in the transmitter (A) and the receiver (B),

transmitter (A) and receiver (B) both receive a public time signal,

transmitter and receiver are synchronized by the time signal or a signal derived therefrom by the channel hopping cycle being started on a previously defined channel in synchronism with the time signal both in the transmitter and the receiver.

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BRIEF DESCRIPTION OF THE DRAWINGS

In the following an example of the invention will be explained more closely on the basis of the drawing.

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FIG. 1 shows a block diagram of a transceiver with a device executed as an additional device for automatic and continuous hopping of transmission channels.

FIG. 2 shows schematically the setup of a connection between two transceivers.

FIG. 3 shows the operation of a transmitter and receiver in accordance with the invention in comparison in the form of a flowchart.

FIG. 4 is a functional block diagram of a channel selecting device.

FIG. 5 is a block diagram of an embodiment of an additional part for a trans~~ceiver shown in FIG. 1 at the bottom right.~~

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

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As indicated by the figure, the transceiver contains radio data transmission device 2 known in the art which is equipped with inventive additional part 1 for protecting transfer of the data signals. Additional part 1 forms a data transfer device suitable for ~~installation in any devices used for data transfer.~~

As mentioned above, radio data transmission is selected only as an example here for explaining the invention. The invention can fundamentally be used in all devices able to transmit and receive data, transfer being effected over one of a plurality of possible channels.

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Departing from the representation in the figure, additional part 1 may also be integrated in transceiver 2.

Data signal source 4, for example an LF section connected to a microphone, provides data signals to signal conditioning circuit 6 via channel switch 10. Signal conditioning circuit 6 modulates the data signals to condition them for radiation through antenna 8. In customary transceivers, channel switch 10 is formed as a manual selector switch for selecting one of the available channels. Reception of data is effected similarly to transmission of data. The receive signals coming through antenna 8 are demodulated, amplified, etc., in signal conditioning circuit 12 and then fed via the channel switch to data signal sink 14, shown in general form here, having loudspeaker 16 connected thereto for example. The details of the device generally described here are known from the prior art and shall not be explained more closely.

Additional part 1 shown on the bottom right in the figure is used for fast and continuous change-over of the particular "active" channel in channel switch 10. For this

purpose channel switch 10 has connected thereto channel selecting device 20 which is in turn driven by channel hopping sequence program part 22. Program part 22 contains a processor and a memory.

Time synchronization of a transmitting and a receiving device is effected with the aid of a clock device containing time signal generator 24 and clock 26. For this purpose, time signal generator 24 receives the public time signal (the signal DCF 77 in Germany) through antenna 25 and forms therefrom second clock signal *s* and minute clock signal *m*. Second clock signal *s* is fed to clock 26 which generates in synchronism with second clock signal *s* a fast pulse train, in the present case a pulse train with a frequency of one megahertz.

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In program part 22 for the channel hopping sequence a plurality of channel hopping sequences are stored.

In the following, the operation of the device with protection of communication by fast channel hopping will be explained.

When one user of the CB radio system wants to speak to another user with a transceiver of the kind shown in the figure, he enters the receiver's identification number via a keyboard not shown. A corresponding code goes via signal source 4 and the channel switch into the signal conditioning circuit. The receiver called, which has the same device as shown in the figure, is in the standby state, thus receiving through antenna 8 the calling signal which is processed via signal conditioning circuit 12 and channel switch 10 so that the call is then recognized.

The dialing operation causes the channel hopping sequence belonging to the selected identification number to be adjusted in the transmitting device. In order to be able to communicate with the dialed device the transmitter must synchronize itself with the receiver. This is done with the aid of time signal generator 24 which provides synchronous minute and second signals in all devices. For example, a certain data word is fed to channel selection circuit 20 in the transmitting device by program part 22, said data word being a channel hopping sequence specific to the identification number. Furthermore, the channel where synchronization is to begin is fixed in advance. At the following minute clock signal the channel where synchronization is to begin is held for a short time period by corresponding circuit-technology measures in the devices. After expiry of this time period, transmitter and receiver work with a syn-

chronous, identical channel hopping sequence. Clock 26 can feed a high-frequency signal (one megahertz) to channel selection circuit 20 which then feeds a corresponding control signal to channel switch 10. The data are then changed over between the different channels in identical fashion both in the transmitting and in the received device. Since only said two devices work in synchronism with this specific channel hopping sequence, all other devices are excluded from communication.

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Channel selection circuit 20 may be for example a register in which a certain pattern identifying the selected channel is stored at each clock. The content of the shift register may be deposited in a memory (EPROM). However, it is also possible to determine the channel hopping sequence on the basis of an algorithm, said algorithm processing the identification number into the channel hopping sequence.

FIG. 2 shows the simplified case of a system with five channels 1, 2 ... 5 and a clock cycle comprising four clocks. FIG. 2a shows cyclical hopping of channels 1, 3, 5, 2, 1, 3, 5 ... of device 1 called by device 2. The call by transmitting device 2 causes the channel sequence of device 2 to be replaced at that moment by that of device 1 and a "start signal" for synchronization to be adjusted, channel "3" here. When these adjustments are finished, device 2 waits for the next agreed time clock, e.g. the second clock of the public time signal. When said second clock, *t*2, comes, the channel hopping sequence begins in device 2.

The two devices are now working fully identically, in terms of channel selection. Accordingly, the two devices can also open a "window" for other data devices. For this purpose a defined channel is e.g. held for several seconds, e.g. in synchronism with the minute clock. In this time other users can dial in. At the end of the "window" all user devices begin to work with identical synchronous channel hopping sequences. Opening the "window", i.e. holding a certain channel in a time interval lasting e.g. a few seconds, can be effected with a special button.

All circuit parts described above and shown in the drawing can be produced with commercial components in the way known to the expert. Additional part 1 in FIG. 1 ~~can also be integrated in a communication device.~~

The procedure shown above for setting up a connection between a transmitter and a receiver is schematically shown in FIG. 3 with the aid of a flowchart.

In accordance with FIG. 3, transmitter A wants to communicate with receiver B. For this purpose, transmitter A sends the identification number of desired target device B (step $SA1$). Dialing device B automatically causes the channel hopping sequence of device B stored in the device to be adjusted in transmitter A (step $SA2$).

During this time, receiver B is in the standby state. That is, (ready-to-receive) it cyclically runs through the unique channel hopping sequence specific to device B (step $SB1$). When the call from device A is received on device B (step $SB2$), device B sends a confirmation signal to device A.

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Device A waits for said confirmation from device B (waiting loop $SA3$). After receipt of confirmation the channel hopping sequence is halted on a predetermined channel. Then the synchronous clock is awaited in accordance with step $SA5$. The synchronous clock occurs in transmitter A at the same time as in device B, namely on the starting channel of the channel hopping sequence cycle.

In accordance with step $SA6$ the channel hopping cycle is started after receipt of the synchronous clock signal. Both in transmitter A and in receiver B the same channel hopping sequence is now cyclically run through, in exact synchronism, so that data exchange between the two devices is possible (step $SA6$ and step $SB3$).

In a slightly less favorable embodiment one can omit step $SA3$ and also the confirmation in step $SB2$.

FIG. 4 shows a functional block diagram of channel selecting device 20 shown in FIG. 1. From the program part for the channel hopping sequence shown in FIG. 1 an item of data representative of the current channel hopping sequence, in the present example (see FIG. 2) the cyclical sequence 3, 5, 2, 1, 3, 5, ..., is loaded into a register. The register cyclically feeds the individual positions to channel switch 10. Synchronization between a transmitter and a receiver is effected here with the channel "3" at the highest position of the register. Clock 26 in FIG. 1 provides the clock signal (CLK) to the register so that the channels are hopped with the corresponding clock frequency.

As mentioned above, the channel selecting device can also work in such a way that an item corresponding to the current channel is loaded into a register at each channel hop.

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FIG. 5 shows a somewhat more detailed embodiment of additional part 1 from FIG. 1. Over antenna 25 the public dial tone signal is received and fed to minute and

Sub A8 concl.

second evaluation means 40. Circuit 40 generates a minute signal and a second signal. Said second and minute signals are used for continuous synchronization of internal clock 42, on the one hand, and for synchronizing a transmitter with a receiver, on the other hand. Since the public time signal is received in synchronism simultaneously in each country, the present invention utilizes this property of the time signal to synchronize transmitters and receivers at any distance from each other. The effort this requires is extremely low.

In FIG. 5, clock 42 drives program counter 45, dwell counter 46 and channel counter 48. Program counter 45 serves to advance channel counter 48. Dwell counter 46 temporarily halts program counter 45 and channel counter 48 so that data exchange in the course of connection setup is possible during this halting time period. After dwell counter 46 has performed a number of counting steps corresponding to a certain time period it is reset to zero, program counter 45 and channel counter 48 being simultaneously started.

Connected to channel counter 48 is drive interface 49 having the function of galvanically decoupling device 1 from the connected transceiver.